EVALUATING THE PERFORMANCE OF THE OPERATION AT THE SAWMILL PRODUCTION COMPANY

TENG LIK CHING (PC 10046)

Thesis submitted in fulfillment of the requirements for the award of the Bachelor of Industrial Technology Management with Hons

Faculty of Technology

UNIVERSITI MALAYSIA PAHANG

2013

ABSTRACT

In this study, it discusses about evaluating the performance of the operation at the sawmill production company. The scope of this study is focusing on the production process in sawmill company. The time frame covered is one year it is in the year of 2013. This study is conducted by using the ARENA simulation software to simulate the modeled process in the simulation software. It is a quantitative study in which the performance is measured by the productivity for the whole system of sawmill. The reducing of the waiting time in the bottleneck station able to provide an improvement in the sawmill production process.

Keywords: Cycle Time, Average Waiting Time, Utilization, ARENA Software, Simulation.

ABSTRAK

Kajian ini membincangkan tentang penilaian prestasi operasi di syarikat kilang papan. Skop kajian ini memberi tumpuan pada process pengeluaran di kilang papan. Tempoh masa yang diliputi adalah satu tahun pada tahun 2013. Kajian ini menggunakan perisian simulasi ARENA untuk menjalankan proses simulation pada model yang telah dibina dalam perisian simulasi. Kajian ini adalah kajian kuantitatif di mana prestasi diukur dengan produktiviti dalam keseluruhan sistem pengilangan papan. Pengurangan masa menunggu di stesen kesesakan dapat membantu dalam peningkatan proses pengeluaran kilang papan

Kata kunci: Masa Kitaran, Purata Masa Menunggu, Pengunaan Sumber ,ARENA Perisian, Simulasi

TABLE OF CONTENTS

LIST OF Tables

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides an overview of the study and outlines its scope. The background of study of this research is to evaluate the performance of the operation at the sawmill production company. This chapter will cover the problem statement, research objective, and research question. Moreover, scope of study, significance of study, and operational definition term also will be proposed through this chapter. The expected result also will be explained in the last part of the chpter1.

1.2 BACKGROUND OF STUDY

Wang, Zhao and Zheng(2005) descried the available of resources and the machines capacities in the system are affect the production system performance such as the circle time, average delay and throughput. Bottleneck is one of the constraint parts on production system, because it can make the whole operation chain become slow down. Wang, Zhao and Zheng also define the system bottleneck based of the Performance in Processing (PIP)

as the measurement instrument of system performance to calculate the capacity of workload and average waiting time of the system. Therefore, to improve the performance of the system, it is important to improve the bottlenecks.

In operation management, bottleneck happen in continuously manufacturing when having a backup in one part of the sequence. Bottleneck can be detected by measuring the production level at each step and by searching at each sequence of the single process. The initial cause of the bottleneck is when certain sequence has a low production level. (Clark, n.d)

According to Krajewski, Ritzman, and Malhotra (2010), bottleneck generally will occur when the workstation in a process has the highest workload, or highest total time per unit processed. To maintain the bottleneck capacity, the idle time at the bottlenecks should be minimize, which are cause the delays in the system and the bottleneck also should has all resources to stay busy.

Goldman (n.d) stated a bottleneck is occurring when the production process capacity is lower than demand placed above the operation. The bottleneck operation should keep running during the employees rest or break time to increases the operation efficiency. It is because the concept of bottlenecks and ‘throughput’ are to maximize the operation efficiency and reduce the negative effects of bottleneck in the operation. Although balancing the operation with the bottleneck cannot increase the throughput, but it can decrease the long queues and work-in-process before the bottleneck. Unnecessary product can be eliminated by balancing the operation to have the better production management.

Simulation software is a technological method which have provides the high agility and integration capabilities which important for product design, development and manufacturing efficiency. (Murphy, and Perera, 2002) A simulation can look and acts like as real life process. Simulation is an accurate computer model which can simulate everything such as running a factory assembly line, or the day-to-day operation of a bank. Usually, simulation is using to test the changing in a process, without taking risk when making the changes in their real process. Simulation can assist people to improve their performance by looking at where a queue of work has accumulate, how equipment and staff

are being utilized and how long the case take, then the problem should be solve appropriately. Simulation is an important instrument to provide a way in which alternative, policies and plan can be evaluated without doing an experiment on a real system. These methods may help the organization to save cost, reduce time-consuming or can be prohibited simply unpractical to do.

According to Simpson (n.d), sawmill product is used in papermaking, home renovation, construction and etc. Although the main operation of sawmill company is to produce board and timbers, but it also produce the waste such as the bark and saw dust. Sawmill is an equipment which using to cut log. The log is sawed into standard-sized of timbers. Usually, it has three types of saws by using the equipment, which are circular saw, band saw and log gang saw. The capacity of a large sawmill can reach to several hundred thousand board feet per day. (The Columbia Electronic Encyclopedia, 2004)

This study will conduct in Principal Alliance Pallet. A sawmill company allocated at Gemas, Negeri Sembilan. The product produce by this company is timber and wastes. The workers work for one shift a day. Their working hours are 8 hours within 1 hour of rest. The working days are 5 days/week. This company want to improve their operation performance to more productive but there have some bottleneck happen at the operation process, so this study is conducted to help the company to identify the bottleneck area and improve the company operation performance.

1.3 PROBLEM STATEMENT

According to Lee (n.d), bottlenecks are happen when the production level at one station is higher than the subsequent station can catch up, will causing the production line become slowdown. Moore (n.d), emphasized if the bottlenecks point move from one station to another station, the process will more difficult and typical to have the perfect balance. However, this problem still can be solving by define the bottleneck areas and increase the capacity to the maximum level at the slowest bottleneck area.

Bottleneck will make the organization to lost profit or increasing the unnecessary expenses in several ways, which when the operation lost productivity because of employees are unable to work at bottleneck area. When order cannot be fulfilled and dissatisfied customer might cause them look for other company. Lee (n.d)

According to Clark (n.d), a bottleneck has a seriously effect on the efficiency of production. The part before the bottleneck needs to slow down their production because subsequent area cannot handle the capacity. While, the station following the bottlenecks' is operating below their capacity because they do not receive enough input to operate at full capacity. A bottleneck can be solved by adjusting the production level in the sequence where the critical area happens. It might be achieved by installing additional machine in parallel to increase the capacity or increasing the labor. If it is impossible to increase the production in that area, it may be more efficient to reduce production capabilities in the other areas to create efficiency.

Principal Alliance Pallet plan to receive more customer order, since the demand of the timber are increases in this few years. However, they are concern if they cannot satisfy the customer order because the production amount is low. The lower amount of throughput in production is difficult for them to fulfill the large amount of customer order in the short period. Normally, their customer needed to wait two week to receive their order. Two week is not the short period for them to wait. The lower productivity in this company may be caused by the bottleneck happen in the production flow since their production process are not smooth then it will affect the company performance. Therefore, this study will be conduct to identify the bottleneck area in the sawmill production flow of Principal Alliance Pallet. Arena simulation modeling method will be using in this study to assists the company to find bottleneck station in the production process. The company might have an effective operation if those able to reduce the waiting time at the bottleneck part.

1.4 RESEARCH OBJECTIVE

The objectives of this study were:

i. To identify the bottlenecks at the company's operation.
ii. To measure the waiting time at these bottlenecks.
iii. To propose an improvement of this operations.

1.5 RESEARCH QUESTION

To achieve the objectives of this study, the following questions were been asked:

i. Which station is the bottleneck station?
ii. How to reduce the waiting time at these bottlenecks?
iii. What suggestions can be purposed to improve the company production operation based on the assess result?

1.6 SCOPE OF STUDY

Since this research is carrying to evaluate the operation performance at the sawmill production, so this study will be conduct in a sawmill product manufacturing company, Principal Alliance Pallet, in Gemas, Negeri Sembilan. The scope of this research will limited to the staffs in the Principle Alliance Pallet who were currently worked at this company and familiar with the production process.

This study is more focus on the bottlenecks problem in the company operation process and to reduce the waiting time at this bottlenecks' station. An observation will be conduct during the site visit activities to help in collecting data, and then the simulation method will be using to identify the bottleneck station in the process. The observation will doing directly through the operation process. Therefore, after getting the data, a simulation model will developed to help in running the simulation software to identify the bottleneck in the workstation. Then a model experiment through scenario will be conducted to find the solution to minimise the waiting time at the bottleneck.

1.7 SIGNIFICANCE OF STUDY

The significance of this study is to investigate the problem during the operation process at sawmill production company, which has influence the productivity and effectiveness of the production process. This research can be used as a guideline or reference for the company to improve their operation performance. The finding of this study were important to help the company to have the smoothly production process. The information obtained through this study will provide strategies for the company to overcome the bottlenecks problems. Through this research, the bottlenecks station in the production process will be identified by using simulation method. Simulation system will help the company to do the more accurate decision to have the more efficient production flow with reduce the waiting time or increase the speed at these bottlenecks workstation. This study assists the company to save the production time, increase the operation capacity, and improve the efficiency of production process flow.

1.8 OPERATIONAL DEFINITION

Performance:

Performance is defined as the action, task or operation in the terms of how successful it is performed. Performance also can used to measure the capabilities of a machine and product in particular conditions.

Sawmill:

The Columbia Encyclopedia, 6th ed. (2012), described sawmill as the equipment or installation which to cut logs, and then sawed into standard-sized boards and timbers. Generally, it has three types of saws by using the equipment: the circular saw, band saw, and log gang saw. A large sizes of sawmill is possible to have a capacity of several hundred thousand board feet per day.

Production bottleneck:

According to investopedia (n.d), production bottlenecks is a point in the production flow which congestion in a system that happens when workloads arrive at that station more quickly than station can handle them. The inefficiencies of bottlenecks will create a queue and a longer cycle time in the system, which was limit the production system performance. The bottleneck system will have output and throughput.

Simulation:

Smith (1998) defined:

"Simulation is a process of designing a model of a real or imagined system and conducting the experiments by the model. The purpose of simulation experiments is to understand the behavior of the system or evaluate strategies for the operation of the system."

1.9 EXPECTED RESULT

The expected result will focus on to get as much as possible of information to answer the research questions. The expectation of this study is to identifying the bottleneck station in the production process. The longer waiting time in the bottleneck will cause the ineffectiveness of operation performance. In this research, simulation method will be using to identify the bottleneck station and to find the appropriate and suitable solution to reduce the waiting time at the bottleneck station.

Therefore, the expected of this research is to find the problem and try to solve the problem by using the simulation method to improve the company operation performance. By reducing the waiting time in bottleneck station is expected to help the company to improve the production performance which maximum the production capacity and to increase the efficiency process flow.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of the literature review is to convey the knowledge and to provide more detail information about this research topic. This chapter explains about operation performance, bottleneck and sawmill company operation. It acts as guidance for the research objective in this study. The strategy which writers used as a way to begin the literature review proceeded from the general, wider view of the research to the specific problem.

2.2 SAWMILL OPERATION

Sawmill operation is the process of cutting logs into timber. The process includes the cross cutting, debarking, sawing, grading, sorting and packaging. Logs is the basic raw material of sawmill. Although, lumber is the main product of the sawmill operation, but it

also produce the by-product such as wood chip, sawdust and residual bark to gain profit. The product is graded into high quality product and low quality product. There have the different size of lumber, according the size specification to meet the customer need and demand.

Zhang (1993) describes sawmill operation is the process of breakdown logs into lumber. Sawmill operation is different from other manufacturing process, because it is no assembly processes. There is only the reduction of the raw material into smaller dimensions. The sawmill product are transform the logs into lumber and by-product. Log is the basic raw material of sawmill. There have two main factor affecting the sawmill performance, which is log throughput and log breakdown. The log throughput is a machine utilization and material flow in sawmills, the higher throughput will affects the mill profit. While, the effect of log breakdown is simpler compare with throughput, because it is define as the higher timber recovery, the higher the income.

According to Sohrabi (2012), there have two classification of sawmill product, which are high-value product and low-value products. High quality lumber pieces are the high-value product, while the low-value product includes the lower quality lumber pieces, wood chips, sawdust and residual bark. The quality of lumber pieces is ranking through grade. The grading is based on the number and location of internal defects been the final dimensions. Although the high-value products are more valuable however, the low-value product also important to supply other sectors of the forestry industry such pulp and paper, biofuel and pellet industries.

2.3 OPERATION MANAGEMENT

Operation is a process or a series of activities that provide a physical good, information or service to the consumer. Beside the process, operation management also include the management of people and resources to provide quality goods and low cost. The operation manager must develop a new strategy for future operation to motivate people

to improve their production efficiency without changing the quality of service, and management of day-to-day operation performance required. The system of performance measurement is the process of performance management for organization to manage its strategic and operation performance to promote a proactive system to control the organization activities, tasks and people by allowing an appropriate management decisions. The system of performance measurement is important for the operation management to planning and control. (Perazza, n.d)

2.4 THEORY OF CONSTRAINT

The theory of constraint (TOC) is a change method for organization to have the improvement of the profit. Constraint is one of the factors that limit the organization to gain profit. In manufacturing environment, constraint is occurring in the production processes which call as bottleneck. The constraint part will limited or slow down the operation process. The organization will lose time during the waiting at the constraint and then it will affect the production profit. The TOC might be a guide for the organization to manage their constraints at the same time increase the profit.

Longcore (1999), stated the improvement of operation in productivity is important for manufacturing organization. Organization will lose profit to pay the price on the bottom line, suffering declining profit and loss of market share, when the organization are failed to increase the productivity. The system bottleneck identification is important into improvement process to allow limited resources for the most effective improvement activities. The system bottlenecks also can call as “most constraining operation”. The theory of constrain that focus on bottleneck process station should be improve the resources. The losses of bottleneck for an hour will same with lost for a whole system. An hour saved at a non-bottleneck is an illusion.

2.5 BOTTLENECK IN OPERATION SYSTEM

Bottleneck is a production activity which delays the performance of a system and reduce the overall process efficiency. A bottleneck machine will make the production process cannot work smoothly, so the productivity of the machine will be decrease. When the efficiency of the system is decrease, it will holds down the whole system capacity. Therefore, it is important to identify the bottleneck to improve the system performance. Bottleneck might occur in different condition, such as machine breakdown, the first machine capacity is high then the second machine capacity, operator problem and other. There will have the longer waiting time at the bottleneck system which can reduce the system efficiency and affect the system performance.

Bottleneck always occurs in factory, usually in machines or processes which control the throughput of the system. Manufacturing center's need to manage their system throughput, WIP, and cycle time. Throughput is the number of final product produced per unit time by the system, WIP is work in process which the material convert into final product in the system, and cycle time is the average of time needed for raw material to be transformed into a final product. Insufficient throughput leads to the demand cannot be achieved. Excessive WIP need excessive capital and excessive cycle time leads to loss customer orders. So, it can simply to conclude that if any of these parameters which influenced by process variability, process time, process reliability, system bottlenecks and the production control system used are not managed properly, then the manufacturing centers' will loses money. (Elftman, 1999)

Pegels and Watrous (2005) defined bottlenecks as an operation that does not have enough capacity to keep up with the required level of throughput. Bottlenecks generally have a lot of work in process (WIP) inventory accumulate in front of them, and downstream operations generally short of the components produced by the operation of congestion. The constraint is consists of mold set, especially during the busy time when having an excess number of customer orders. The number of molding set-ups that needed is exceeding the production mechanics capacity that able to complete. The molded parts

producing will delay in the downstream operations to complete the orders. The constraints do not have a huge amount of work-in-process inventory in front, because the molding of component parts is into the first stage of the production sequence. Constraint is not specific to any product, but it more systematically impacts the production of all products.

Bottleneck is the capacity of resource is less than or equal to the demand. A bottleneck in manufacturing is easy to identified, which it have a stack of work-in-process in front of a resource. But it is difficult to identify the bottleneck in services, because it no stack of work-in-process. System performance can be improves after removing the bottleneck. But the process is repeated, because the removal of one bottleneck same with another bottleneck takes place. Through the theory of constraints, constraints' in a system also called as bottlenecks. Bottlenecks can be processes machines that have limited production capacity or activities that limit the company to achieve their goal. It is important to identify the system bottleneck if possible, because throughput can be improved and WIP can be reduced through reducing the impact of bottleneck in the operation. (Ellis, 2011)

Narayanasamy (2007) mention a production system consists of a set of machines to process the raw material into finish goods. Bottleneck machine is one of the problems that happen in production system. The bottleneck in production system is a flow of product in any system which disrupted by operator failure, machine failure and material failure. The failure of machine would disrupt the whole system. 30 to 40 percent of the system efficiency would reduce through the bottleneck machines and also would holds down the whole system capacity. Therefore, it is important for doing bottleneck identification to reduce the bottlenecks to improve the production system. The bottleneck is identifying in the longest queues length method, lowest production rate, buffer with high WIP, lowest blockage and starvation time. All of this problem can be solve by using the simulation. Appropriate size of buffer should be allocated into bottleneck station for improving the system performance. When the total work-in-process inventory is increase in the system, the WIP is needed to maintain by controlling the output rate of non-constraint machine and buffer after the bottleneck machine to increasing the system performance. The simulation is used to estimate the throughput.

Ucar (2012) agrees maintenance operation should not be considered separately with the making productivity related decisions. Maintenance is important for the smoothness of production system, which on-time repair can improves the production performance of the whole plant when the availability and reliability of the machine increasing. The machine that always breakdown would identify as the bottleneck machine. The bottlenecks identification will be using through simulation method to detect the bottleneck machine. The bottleneck machine initial condition information can see through the machine age, maintenance history, buffer levels, operational status of machines and scheduled production model mix of that shift. The production equipment requires the proper maintenance and management to avoid the disruption in the production operation. Therefore, maintenance management decision making is needed to have the smooth production process.

According to Timilsina (2012), in a manufacturing company, the production line would connect to each other, although they has different production line. Since, the output for one station will be the input for another station. Therefore, bottleneck will occur when one of the lines is broken due to some reason. It is because the broken of one machine will directly affected to other production lines which causing lower lever of output. The system is called as bottleneck when the inflow rate is higher than the outflow rate, it will reduce the system efficiency.

Beside the machine, labor, time and material also is a part of the bottleneck in manufacturing industry. Generally, bottleneck can be described in people constraint, material constraint, equipment constraint, process constraint and management constraint. The most challenges for company are to manage their employee. In any manufacturing unit there have different people working together with different style, experience, and education background. The general constraints because of people are illness, unexpected vacancy, hiring and training problem. The material constraints is the poor inventory management, not accurate forecast, poor production planning and inefficient supplier, which may cause the improper material flow that reduce the production capacity and increase the lead time. The constraint of equipment is consisting of machine breakdown, not accurate planning, lack of spare parts, and improper maintenance make the equipment for manufacturing cannot achieve the current demand. Process constraint includes the quality problems, poor

plant layout, insufficient resources and inflexible process, which affected the entire output of the system. Management constraint means the lower performance that has lower output and profit. The objective of the company is not able to achieve such as because of lost power of employee, ineffective flow of material and information. Capacity planning is requiring for the manufacturing operation. The manufacturing capacity planning is to plan for designing plant layout, installing machine, and arranging the factors of production for specific time. The capacity planning should be able to meet the future demand and able to produce the enough goods and service to meet the customer. Capacity planning can help the company to make more profit.

Tamilselvan (2010) found, the efficiency of the production system is determined by the production rate. The machine that has the large volume production system can have higher performance level, which can achieve to 60% to 70% of system capacity. The high utilization machine will always block and impedes other machines, which called as a bottleneck machine. Therefore, it is important to identify the bottleneck and scheduling strategies to reducing the impact of the bottleneck machine to improving the system performance. The bottleneck can be classified based on the duration which is short term bottlenecks and long term bottleneck machine in the system. Short term bottleneck machines are the block into the system performance for short time, while long term bottleneck machine is which has blocked the system performance for long time.

There have many identification method of bottleneck such as, queue length analysis method, machine utilization method and active duration method. Machine utilization method is to identify the bottleneck through calculating average time for each machine spends which the highest utilized machine is more potential to be the bottleneck machine. The queue length analysis method is used to measure the waiting time of the different machines. However, this method is not suitable for the systems that have different queue sizes and no upstream and downstream buffer. The active duration method is each machine can be classified as active and inactive states. The active state is the machine is processing a part, while inactive state is when the machine waits for a new part, blocked by respectively machine and failure time of the machine.

2.6 SIMULATIONS AS THE BOTTLENECK DETECTED TOOL

Simulation is designed a model and conducted the experiments by using the model development. The experiments which conduct into the simulation will look like doing the experiment in the real production system. The simulation software will run with the graphical model to detect the bottleneck part into the production flow. The simulation will automatically analyze the problem and provides a data for the production manager doing a decision making to solve the problem. The simulation can be an instrument for evaluating the system performance.

According to Leporis and Kralova, (2010), simulation-based method is more suitable for manufacturing real production process. Although, it is more time-consuming to produce the simulation model, but the simulation experiments provide the more sufficient information result to detect a bottleneck in the system. An advanced simulation system is offer detailed statistics of the average utilization, waiting, blocking and breakdown to each element of the model as a result of the experiment. In addition, the simulation model also can help the company to determine the possibility of the improvement of the system and verify their impact on the overall system performance.

In manufacturing, the system productivity and quality can be improved through focusing in bottleneck. The bottleneck detection method would be used to identifying the bottleneck location in a production line to help the company to improve their system performance. The time lost at the bottleneck would make the overall system lost the time, so it is impossible for a production system to saved time at a bottleneck. A machine becomes a bottleneck machine when the production rate of the system is higher than other machine. The effectiveness of a system would be confirmed by simulation and then the system improvement is evaluated through the increasing of the bottleneck capacity. All of the machine average duration in the system line can be calculated by using simulation, and it known as active state duration method. The highest average duration machine would identify as the bottleneck machine. The simulation model can automatically analyze the bottleneck to detect the constraints into the running production. The results from the

simulation are more accurate in bottleneck analysis and can quickly suggest the improvement strategies in the system. The main purpose of the simulation study is to help the company to improve their production line productivity and efficiency. (Karthikryan, 2010)

Process times is need to balance with the material flow in sawmill operation and to motive the performance of the operators. The operators tend to accelerate the operation when there have a bottleneck in material which waiting to process. There are no materials at the downstream machine when the bottleneck was happen in the upstream machine center. Therefore, the original process pattern needs to be change to have the smooth flow of material. However, the current machine center will have the pressure to speed up the operation process. The process time taken for sawing mills of large grade log is different. The feed speed is adjusted with the height of saw kerfs based on the mills head saws. The area of the face had sawn maybe proportional with the process time. High-speed modems and high processing sawmill are designed for small logs. Beside that the high power machine also is using for the small logs saw, because the process speeds of these machines are almost constant. The process time is solely proportional with material length. This type of sawmill generally have in the softwood dimension sawmills. All of these problems will detect by the simulation method and the new process pattern will be test by the simulation software to find the most appropriate pattern for the process system. (Zhang, 1993)

Bahtiyar (2005) state, simulation is an operation system model which as a tool to evaluating the system performance. Simulation is used to test the operation system before the system is built by using a model, it can reduce the risk of failure to achieve the specification, eliminate the bottleneck, to optimize the performance of system and to avoid the less or excess utilization of resources. Simulation is using to identify the bottleneck station in the production line and help the company to determine the root cause of the problem happen. The problem can be solving well before the implementation because simulation is a highly sensitivity analysis software that can quickly analyses the problematic data. The Arena simulation modeling system is an animated simulation models which need to design and develop an overall graphical model. The place of graphical object will be analysts. The graphical objects include the system components for example as